International Basic and Applied Research Journal

Journal homepage: https://sites.google.com/site/ijbarmeplrf/

Research Article (Subject –Remote sensing, Palynology, Paleoceanography)

A Quantitative Estimation of Distance of Landward Migration of Sea Water which Occurred about 49 Million Years Ago in Kutch, Gujarat, India

Vinay K. Sahay*, Bandana Samant[1] & Shyam N. Mude

[1]PG Department of Geology, Rashtrasant Tukadoji Maharaj Nagpur University, Law College Square, Nagpur, India.

Department of Geology, Fergusson College, Pune, India.

*MEPL Research Foundation, Chandrapur, India.

Received: 20 May 2016, Revised Received: 27 May 2016, Accepted: 28 May 2016

Abstract

This article presents the result of a first ever study on quantitative estimation of landward migration of sea water in Kutch during Early Eocene time using remote sensing and palynofossils. We report that the sea water was transgressed upto 16 kms inside the land, during Early Eocene (~49 million years ago), in the Kutch region, Gujarat, India. The sea water migration distance suggests that during Early Eocene the climate was much warmer, in comparison to present climate. Our utilized approach is quite useful in paleoceanographic study for regional or global correlation.

Keywords: Sea water migration, Distance, Remote sensing, Palynofossils, Paleoceanography, Kutch, India

Introduction

The Kutch basin is an elliptical-shaped pericratonic shelf basin with well developed Tertiary sequences over basement Deccan Traps. The basin extends far to the west over the present continental shelf (Biswas, 1992). The Tertiary sediments are developed in the western part of this basin with major part occurring in offshore region extending up to the present continental shelf. Naredi Formation, comprising of mixed siliciclastic lithological succession, was classified by Biswas and Raju (1973) after the village Naredi situated in the western part of the Kutch. The type section is exposed above the ground along Kakdi River near Naredi and in parts along the Guvar River to the north-north-west of Naredi village. Apart from this many researchers studied the Naredi Formation sequences in Kutch and provided further sedimentological and paleontological insights on the Formation (Tandon, 1971; Venkatachala and Kar, 1969a, 1969b, 1969c; Kar, 1985; Misra, 1992; Singh, 2002; Singh and Singh, 2005; Garg et al., 2011). Till now no one study has measured quantitatively the landward migration of sea water in Kutch region where Naredi Formation type section of Early Eocene age was deposited. This study quantitatively measures, for the first time as

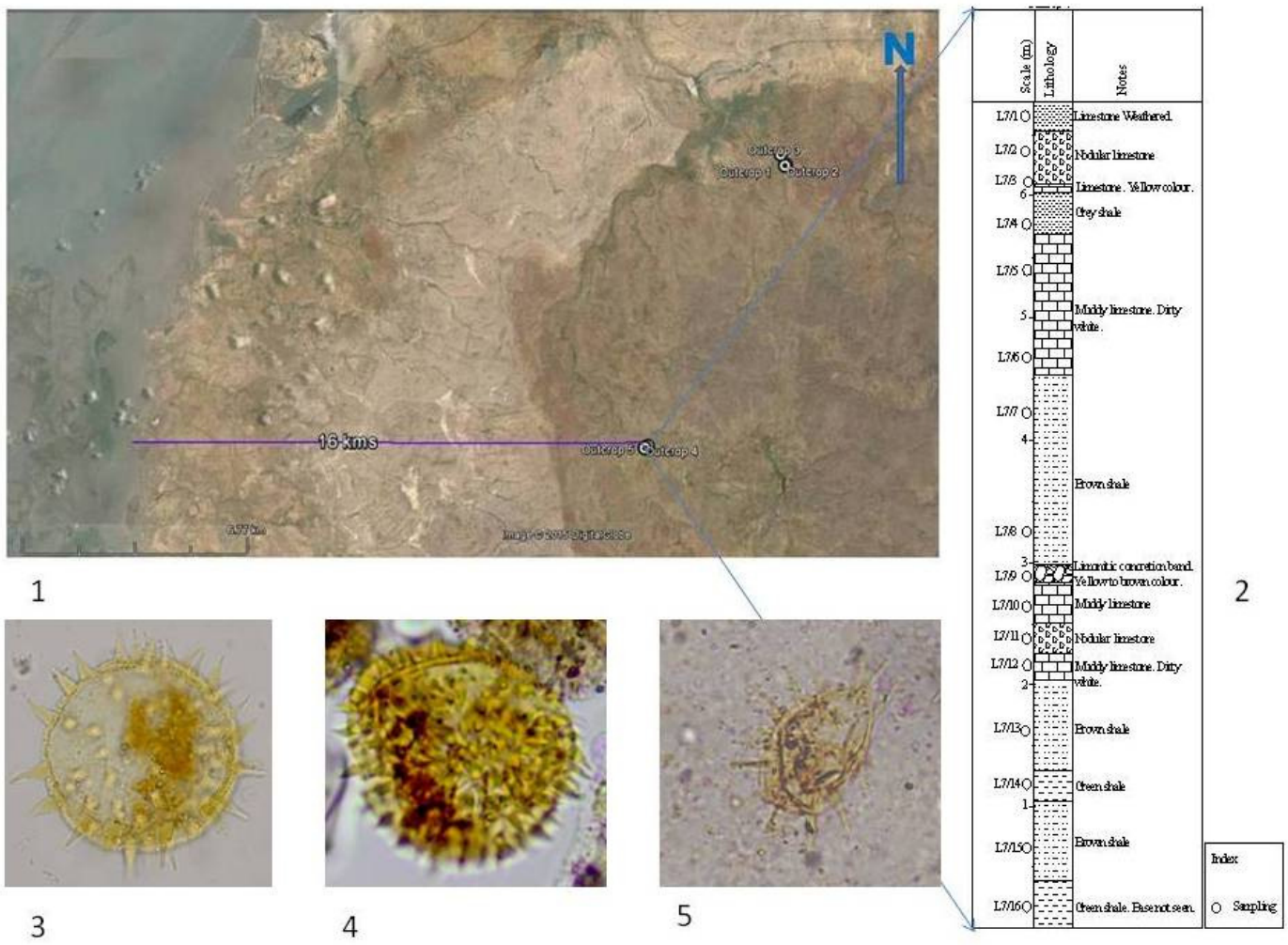

Fig. 1. (1) Satellite imagery of Kutch region with location of the Naredi cliff section sediments, Early Eocene. The distance from the Naredi cliff section to present sea coastline water is about 16 kms. (2) Litholog of Naredi cliff section. (3) *Spinizonocolpites echinatus*. (4) *Spinizonocolpites thanikamonii*. (5) Dinoflagellate. All these palynofossils recovered from the green shales of the Naredi cliff section.

per our understanding based on review of earlier literatures, the landward migration distance of the sea water which took place during Early Eocene (~49 million years ago).

Material and Methods

To fulfill the objective remote sensing and palynological techniques were utilized. Palynological analysis provided the palynofossils which are indicative of marine conditions. Remote sensing analysis, using geographic information system software, provided us the distance of the Naredi type section site, from where marine palynofossils recovered, to Present sea coast area, Kutch (**Fig. 1**).

Results and Discussion

The Naredi cliff section green shale sediment samples showed the predominance of brackish water mangroves pollens like *Spinizonocolpites echinatus* (*Nypa* botanical family), *Spinizonocolpites thanikamonii* (*Nypa* botanical family), *Marginipollis kutchensis* (*Barringtonia* botanical family) and few dinoflagellates. At

present, mangroves worldwide cover an approximate area of 240 000 km^2 of sheltered coastlines (Lugo et al. 1990). Mangroves can establish and grow under a relatively wide range of flooding and salinity conditions, but is generally restricted to the intertidal zone where there is less competition with freshwater plants. The distance measured, using GIS software, from this Naredi cliff site to present sea coast water shows about a distance of 16 kms. These data suggest that sea coast were about 16 kms inside the land area, during Early Eocene, in comparison to the present sea coast location (**Fig. 1**). This sea level rise and landward migration of sea water may be related to the Palaeocene/Eocene thermal maximum event which was a brief period of widespread, extreme climatic warming (Zachos et al. 2003; Tripati and Elderfield, 2005), that was associated with massive atmospheric greenhouse gas input (Dickens et al. 1995). During this time period the Earth's surface temperature rose globally by 5-9 degrees celsius within a few thousand years, while simultaneously, large amounts of carbon were released into the ocean-atmosphere system (Zachos et al. 2003). Khozyem et al. (2013) in their study on Naredi Formation observed a negative excursion that is correlative with the global Early Eocene climatic optimum event. The Intergovernmental Panel on Climate Change (IPCC 2001) predicts that by 2100, global warming will lead to a sea-level rise of between 110 and 880 mm. Recent study shows that global sea level has rise by ~14 cm in the 20^{th} century (Kopp et al. 2016), which is primarily due to contributions from thermal expansion and glacier mass loss (Gregory et al. 2013). These data suggest that during Early Eocene climate was much warmer, in comparison to present climate, which lead to landward migration of seawater, in Kutch region of Gujarat, upto the extent of about 16kms.

Conclusions

Our study shows quantitatively, for the first time, that the sea water was transgressed upto 16 kms inside the land area, during Early Eocene (~49 million years ago), leading deposition of Naredi cliff section in Kutch, Gujarat, India. During Early Eocene the climate was much warmer, in comparison to present climate. Our utilized approach and technique can be useful in paleoceanography study.

Acknowledgement

The authors' thanks Professors and Head Dr. P. Kundal and Dr. D. B. Malpe, Post Graduate Department of Geology, Rashtrasant Tukadoji Maharaj Nagpur University for all support. Author thanks reviewer for suggestions which improved an earlier version of the manuscript.

References

Biswas, S.K. and Raju, D.S.N. 1973. The rock stratigraphic classification of the Tertiary sediments of Kutch. Bulletin ONGC, 10, 37-46.

Biswas, S.K. 1992. Tertiary stratigraphy of Kutch. Journal Paleontological Society of India, 37, 1-29.

Chattoraj, S.L., Banerjee, S. and Saraswati, P.K. 2009. Glauconites from the Late Paleocene – Early Eocene Naredi Formation, Western Kutch and their genetic implications. Journal Geological Society of India, 73, 567-574.

Dickens, G. R., O'neil, J. R., Rea, D. K. & Owen, R. M. 1995. Dissociation of oceanic methane hydrate as a cause of the carbon isotope excursion at the end of the Paleocene. Paleoceanography, 10, 965–-971.

Garg, R. Prasad V. Thakur, B. Singh, I. B., and Khowaja Ateequzzaman. 2011. Dinoflagellate cysts from the Naredi Formation, Southwestern Kutch,

India: Implications on age and Palaeoenvironment. Journal Palaeontological Society of India, 56 (2), 201-218.

Gregory, J. M., et al. 2013. Twentieth-century global-mean sea level rise: Is the whole greater than the sum of the parts?. Journal of Climate, 26 (13), 4476–4499.

Intergovernmental Panel On Climate Change (IPCC). 2001. Intergovernmental Panel on Climate Change Third Assessment Report—Climate Change 2001. Synthesis Report. http://www.ipcc.ch/pub/reports.html.

Kar, R.K. 1985. The fossil floras of Kutch IV. Tertiary Palynostratigraphy. Paleobotanist, 34, 1-280.

Kopp, R. E., Kemp, A. C., Bittermann, K., Horton, B. P., Donnelly, J. P., Gehrels, W. R., Hay, C. C., Mitrovica, J. X., Morrow, E. D. and Rahmstorf, S. 2016. Temperature-driven global sea-level variability in the Common Era. Proceedings of the National Academy of Sciences. doi: 10.1073/pnas.1517056113.

Lugo, A.E., Brown, S., and Brinson, M.M. 1990. Concepts in wetland ecology. In: A.E. Lugo, M. Brinson, and S. Brown (eds.). Ecosystems of the World. 15. Forested Wetlands. Amsterdam: Elsevier Science. pp. 53-85.

Misra, B.K. 1992. Spectral fluorescence analysis of some lignite macerals from Panandhro lignite (Kutch), Gujarat, India. International Journal of Coal Geology, 20, 145-163.

Singh, A. 2002. On a striking fluorescing microcomponent from Indian Tertiary lignites. International Journal of Coal Geology, 51, 59-65.

Singh, A. and Singh, B.D. 2005. Petrology of Panandhro lignite deposit, Gujarat in relation to palaeodepositional condition. Journal of Geological Society of India, 66, 334-344.

Tandon, K.K. 1971. Occurrence of *Venericardia beaumonti* d'Archaic and Haime from Naredi, South-Western Kutch, India. Geophytology, 1 (1), 70-74.

Tripati, A. and Elderfield, H. 2005. Deep-sea temperature and circulation changes at the Paleocene-Eocene thermal maximum. Science, 308, 1894–-1898.

Venkatachala, B.S. and Kar, R.K. 1969a. Palynology of the Tertiary sediments of Kutch 1. Spores and pollen from the borehole no.14. Paleobotanist, 17(2), 157-178.

Venkatachala, B.S. and Kar, R.K. 1969b. Palynology of the Mesozoic sediments of Kutch, W. India-11. Three new species of Applanopsis with remarks on the morphology of the genus. J.Sen. Mem., Vol. 33-34.

Venkatachala, B.S. and Kar, R.K. 1969c. Palynology of the Mesozoic sediments of Kutch, W. India-10. Palynological zonation of Katrol (Upper Jrassic) and Bhuj (Lower Cretaceous) sediments in Kutch, Gujarat. Paleobotanist, 18 (1), 75-86.

Zachos, J.C., Wara, M. W., Bohaty, S., Delaney, M.L., Petrizzo, M.R., Brill, A., Bralower, T.J. and Premoli-Silva, I. 2003. A transient rise in tropical sea surface temperature during the Paleocene-Eocene Thermal Maximum. Science, 302, 1551-1554.

Cite this article: Sahay, V. K., Samant, B. and Mude, S. N. 2016. A quantitative estimation of distance of landward migration of sea water which occurred about 49 million years ago in Kutch, Gujarat, India. International Basic and Applied Research Journal, volume 2, issue no. 6, pp. 1-4.